



BUILDING THE WEB OF THINGS

For the past 10 years, one layer at a time, one million things at a time...



Smarter products
come with EVERYTHNG

Company Overview



Model: B2B Enterprise level Platform as a Service

History : Launched in 2012

Founders : Highly experienced technology leaders,
Specialized Web-of-Things technologists (MIT / ETH)

Team : 50 people and growing at speed (London, New York, San Francisco)

Key
Investors :



ATOMICO

BHLP



DAWN CAPITAL



Serving global brands that require SCALE

Coca-Cola



AVERY
DENNISON



Domestic
& General



iHome
Live Life Loud

Mondelēz
International



DIAGEO Gooee

Market opportunity and inevitability



83 Million cars

2.3 Billion computing devices

6.0 Billion RFID chips

19 Billion microcontrollers



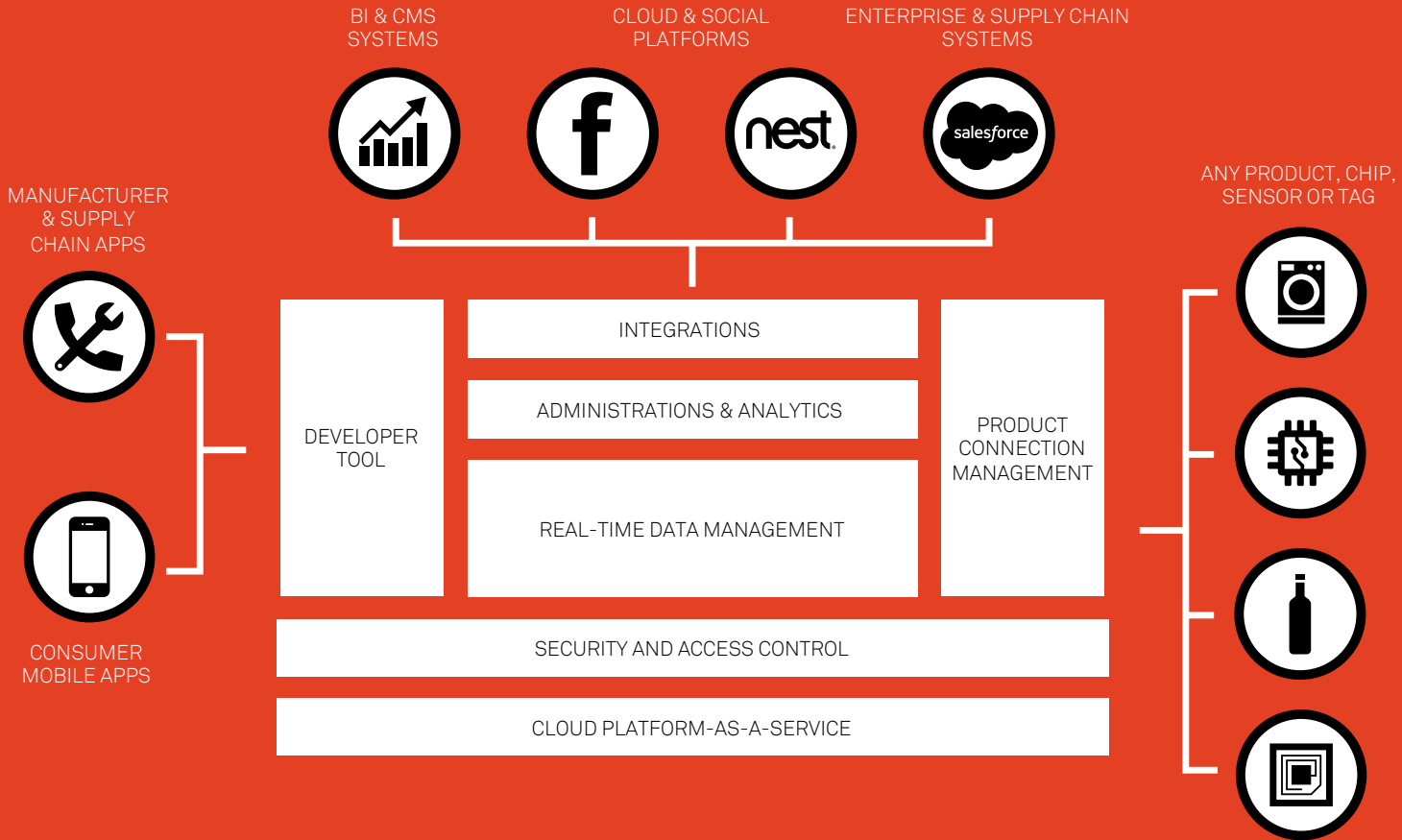
80 Billion apparel items



5-10 Trillion consumables






EVERYTHING - Smart Products Platform



Today's menu



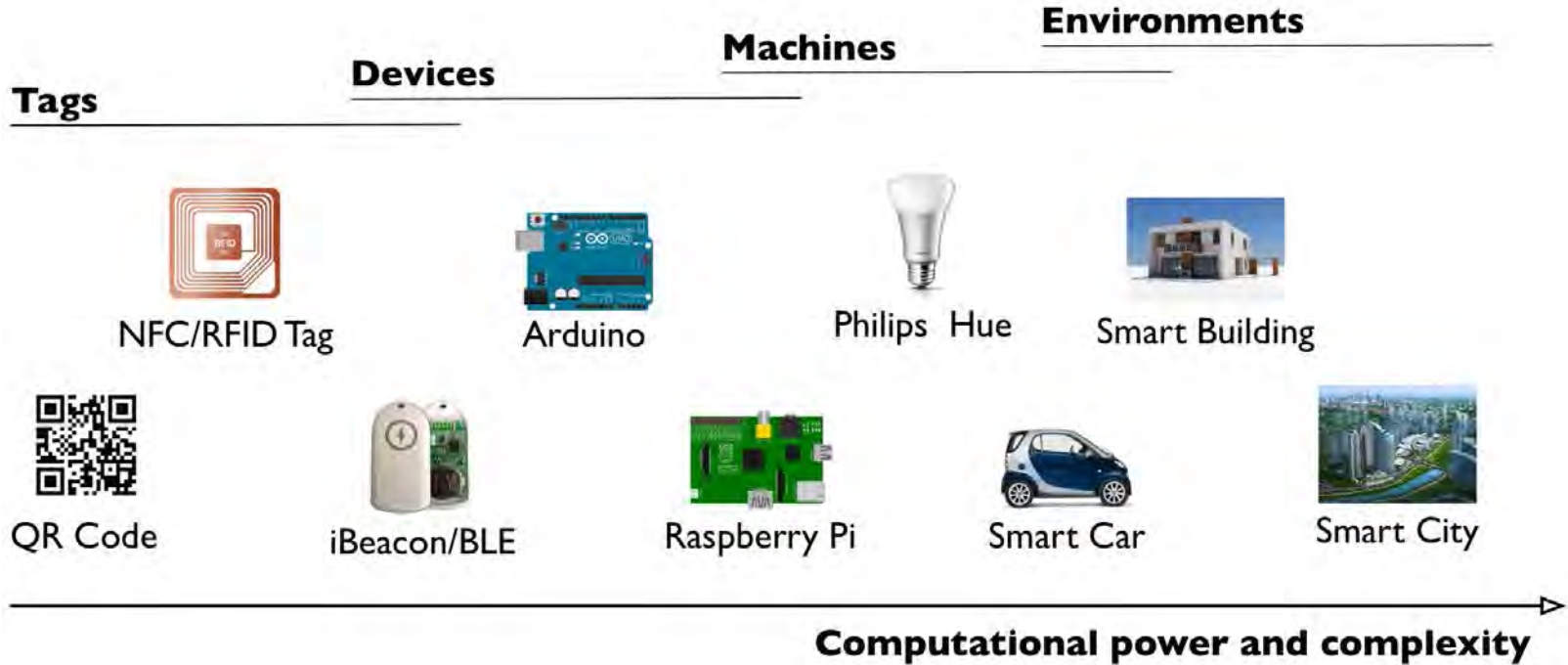
 ON TOAST	 THE GINGER PIG	 BUNS
MUSHROOM SMOKED BACON, GARLIC MUSHROOMS, FRIED EGG ON SOURDOUGH V OPTION AVAILABLE £5	HONEST BRUNCH SMOKED BACON, CUMBERLAND SAUSAGE, BLACK PUDDING, FRIED EGG, GARLIC MUSHROOMS, BUBBLE & SQUEAK, HONEST BEANS AND SOURDOUGH £9.5	BACON SANDWICH THICK CUT SMOKED STREAKY BACON AND FRIED EGG SANDWICH WITH BREAKFAST GRAVY £5.5
AVOCADO BRINDISA CHORIZO, GUACAMOLE, RADISH, FRIED EGG ON SOURDOUGH V OPTION AVAILABLE £6.5		BUBBLE & SQUEAK BUBBLE & SQUEAK, FRIED EGG, TOMATO, AMERICAN CHEESE, KETCHUP £3.5
GRANOLA SEASONAL FRUIT GRANOLA, HONEYED YOGHURT AND MIXED BERRY COULIS £4.5	SPECIAL TWO PORK RIB-EYE STEAKS, HONEST BEANS, BREAKFAST GRAVY AND A FRIED EGG £8.5	BRUNCH BURGER BEEF PATTY 120G, SMOKED BACON, RED LEICESTER, GARLIC MUSHROOMS, BUBBLE & SQUEAK AND KETCHUP SERVED WITH ROSEMARY SALTED CHIPS

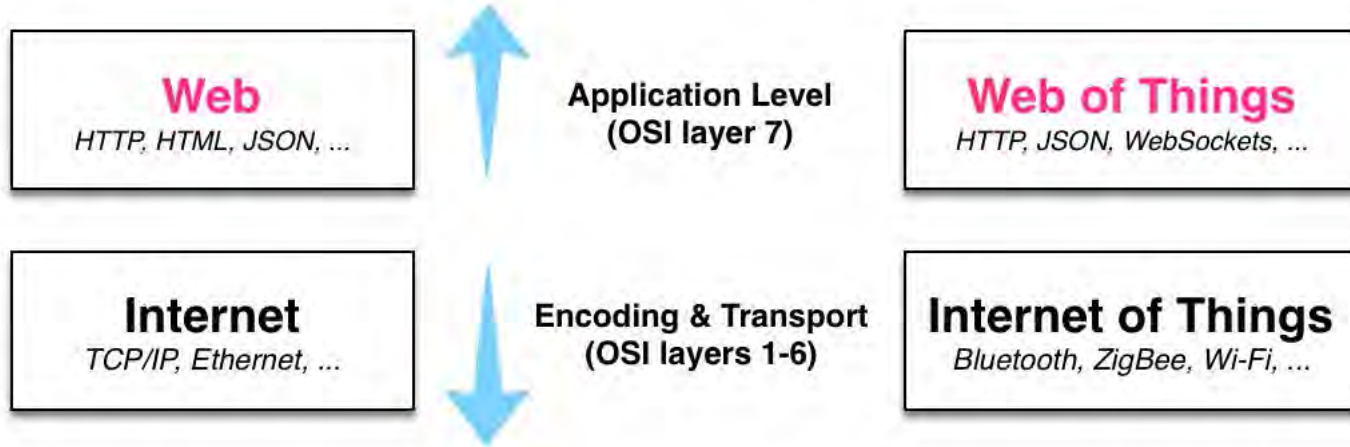
- From IoT to WoT
- Building the Web of Things
 - Layer
 - Discussion
 - Case-study @ EVERYTHING

From IoT to WoT

Bootstrapping the Web of Things

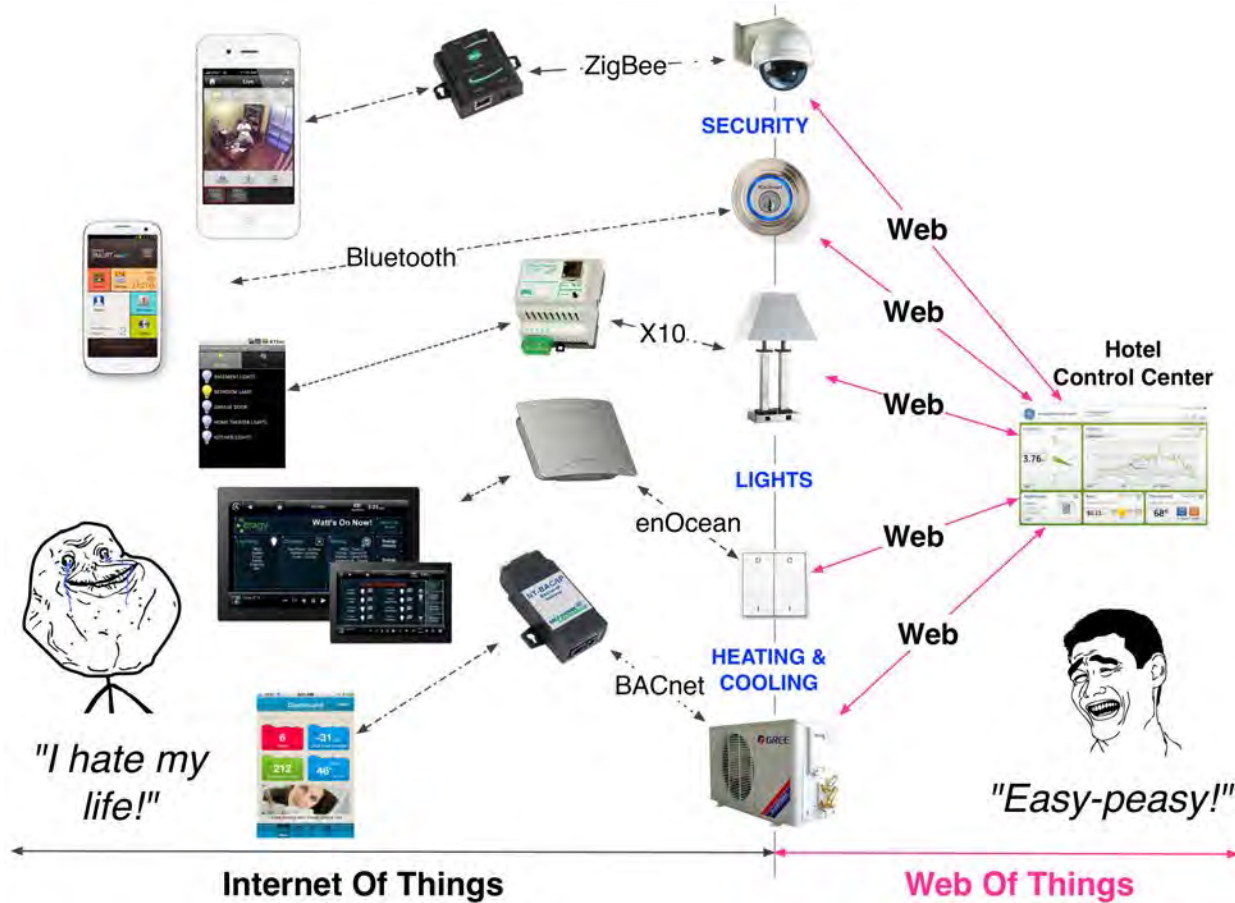
What are the Thing in the IoT?





Research Question: «How can the Web be leveraged to ease the development of Internet of Things applications and bring it closer to non-specialists?»

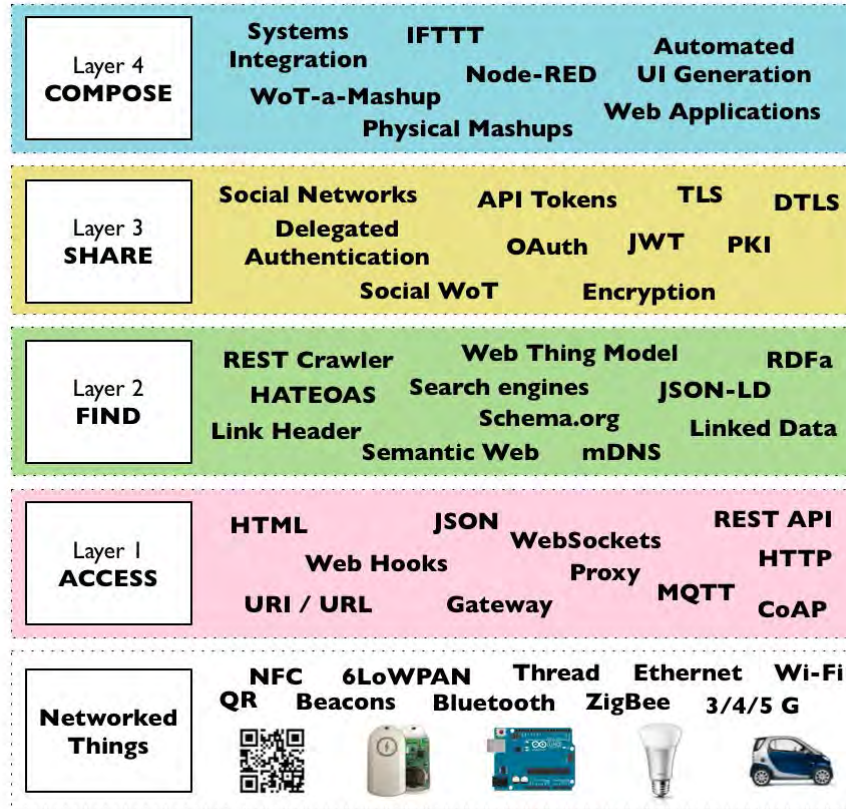
The Web of Things vs the IoT



Building the Web of Things

Layer by Layer

The Web of Things Architecture

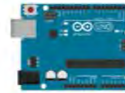


Source: Building the Web of Things: book.webofthings.io
Creative Commons Attribution 4.0

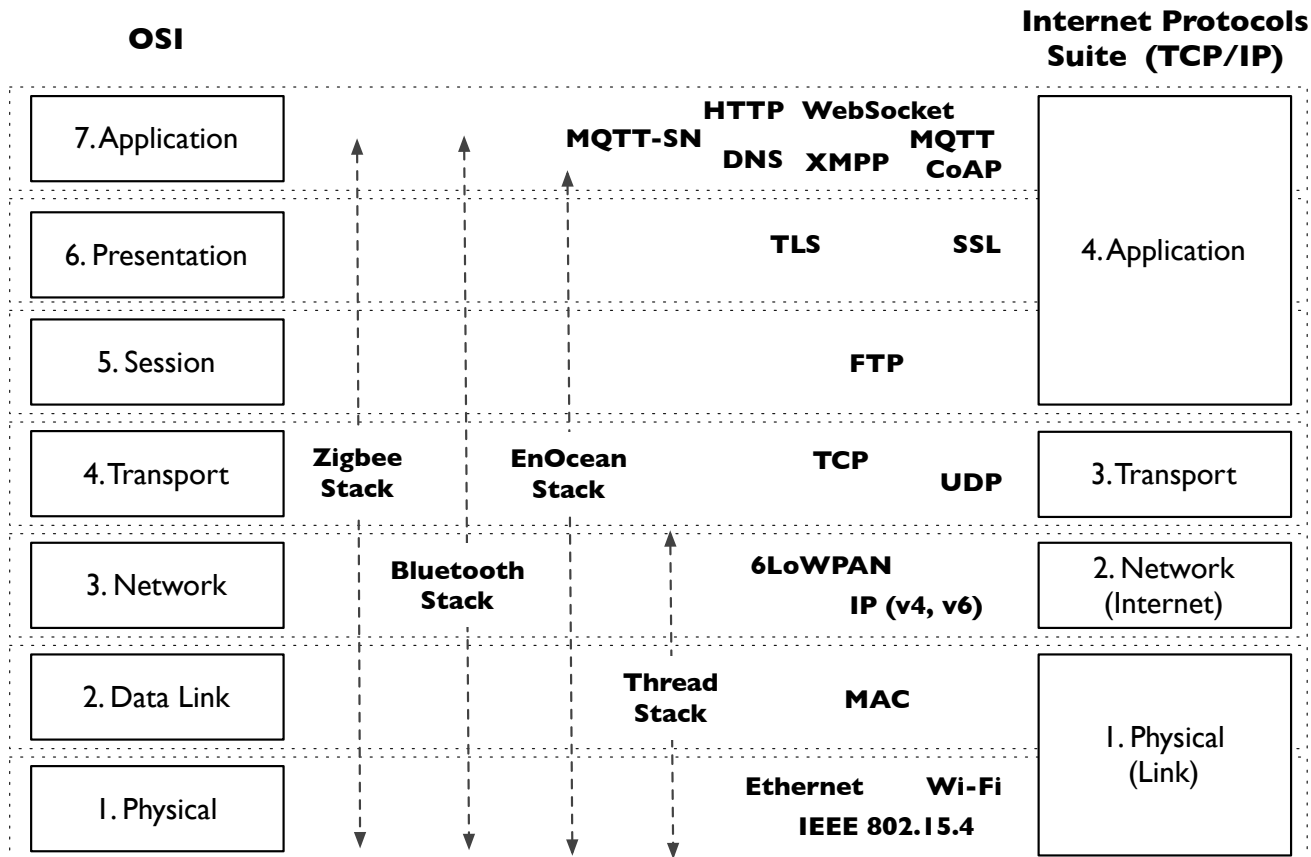
0. The Network

**Networked
Things**

NFC 6LoWPAN Thread Ethernet Wi-Fi
QR Beacons Bluetooth ZigBee 3/4/5 G



1. Choose a Physical Protocol



2. Choose a Network Protocol: IPv4 VS IPv6, 6LoWPAN



IPv4 Address

146.200.15.222



8 bits



4 x 8 bits = 32 bits

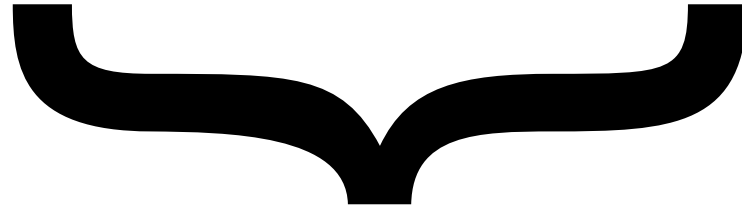
$= 2^{32} = \sim 4.3$ billion addresses

IPv6 Address

2001:db8:0:1234:0:567:8:1



16 bits



8 x 16 bits = 128 bits

$= 2^{128}$ addresses

3. Choose a Transport Protocol: TCP vs UDP



Dom Perignon Button



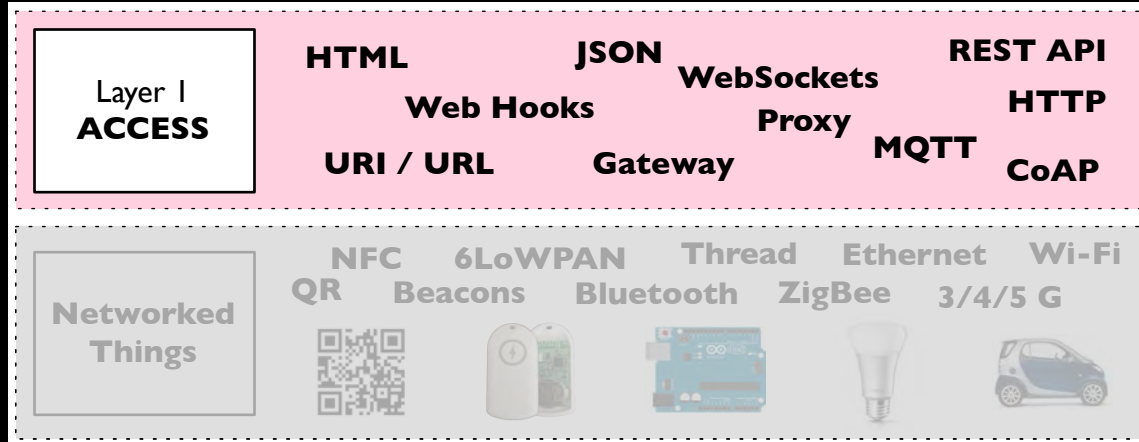
- Get Champagne at the click of a button
- Drop it in a room!
 - Thick walls
 - Wi-Fi requiring browser login
- 2G – SMS connectivity

Discussion: Layer 0 – The Network



- Fragmentation needs to be resolved to fulfill the promise of the IoT!
- There will **not** be one protocol to rule them all!
 - Power consumption & battery power
 - Environment of a deployment
- Convergence to Internet Protocols
 - IPv6 (6LoWPAN, TCP/UDP)
- Consolidations will take place (and need to!):
 - PAN: Zigbee 3.0 – Thread - Wi-Fi HaLo
 - LPWAN: SigFox – 5G
- Pick the simplest path:
 - ~10 years for routers to be rolled out

1. Access Layer



Basic principle: a URL for each Thing

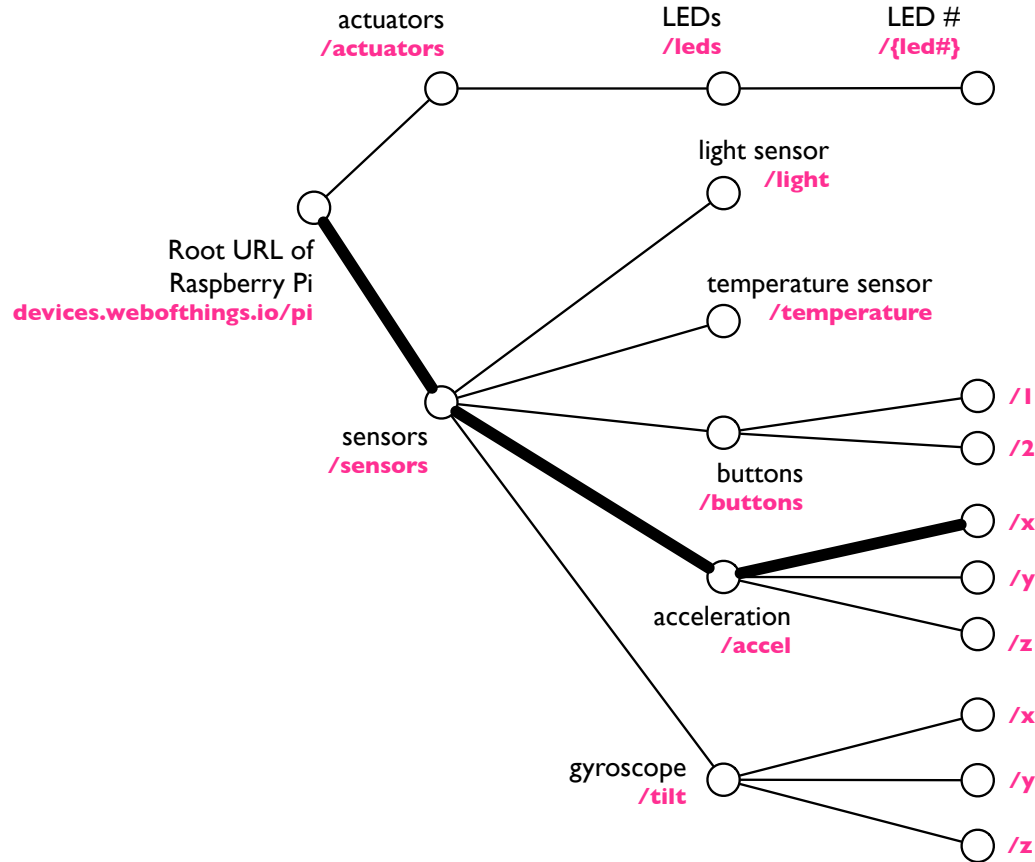


HELLO
my name is

<http://tn.gg/JANFvB4u>

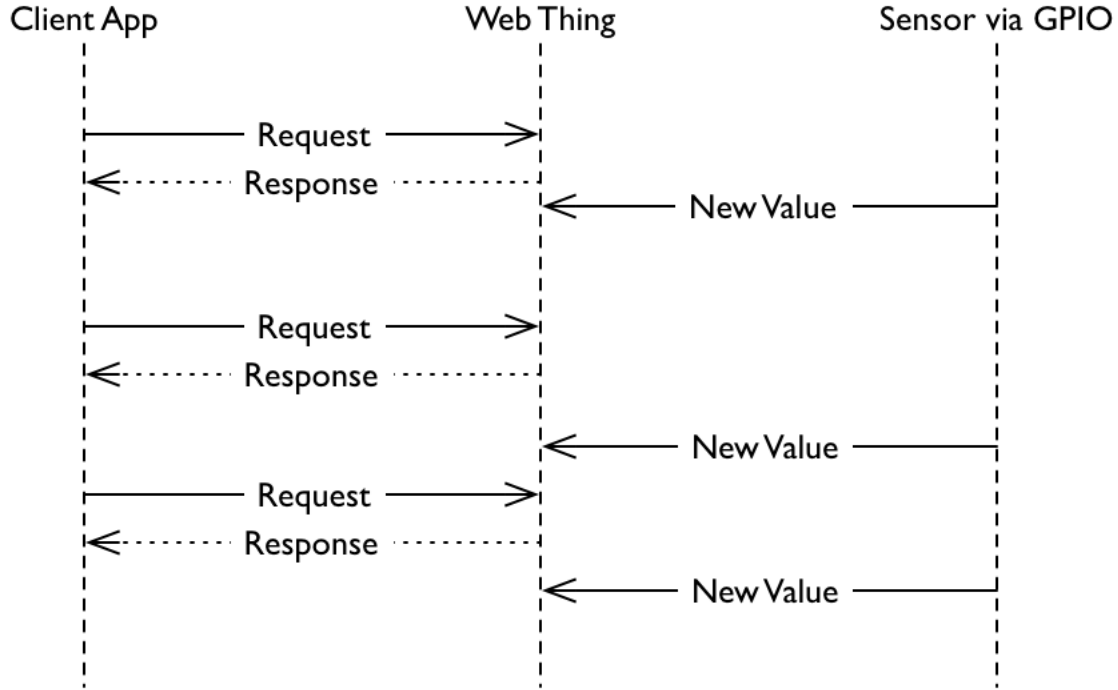


And a RESTful API

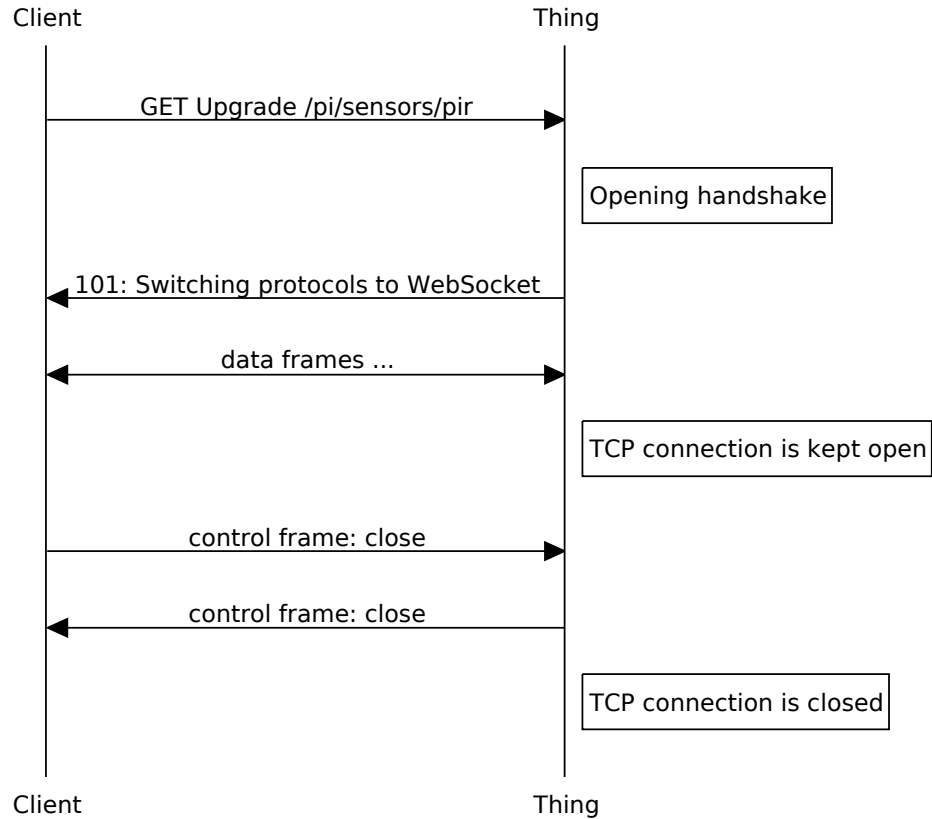


Demo!

The real-world is event driven



The Web has WebSockets



Demo!

WebSocket Upgrade in the browser



101 GET temperature

Request URL: http://localhost:8484/pi/sensors/temperature
Request method: GET
Remote address: 127.0.0.1:8484
Status code: 101 Switching Protocols
Version: HTTP/1.1

Filter headers

Response headers (0.171 KB)

- Connection:** "Upgrade"
- Sec-WebSocket-Accept:** "JZj+/SwlP1bMtGJC9/nuYXMTv2E="
- Sec-WebSocket-Extensions:** "permessage-deflate"
- Upgrade:** "websocket"

Request headers (0.568 KB)

- Host:** "localhost:8484"
- User-Agent:** "Mozilla/5.0 (Macintosh; Intel Mac OS X 10.11; rv:45.0) Gecko/20100101 Firefox/45.0"
- Accept:** "text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8"
- Accept-Language:** "en-US,en;q=0.5"
- Accept-Encoding:** "gzip, deflate"
- Sec-WebSocket-Version:** "13"
- Origin:** "http://localhost:63342"

All HTML CSS JS XHR Fonts Images Media Flash Other One request, 0 KB, 0.01 s Clear

Net CSS JS Security Logging Server Clear Filter output

```
{ "name": "Temperature Sensor", "description": "An ambient temperature sensor.", "unit": "celsius", "value": 11, "gpio": 12 } websockets... :8:13  
{ "name": "Temperature Sensor", "description": "An ambient temperature sensor.", "unit": "celsius", "value": 1, "gpio": 12 } websockets... :8:13  
{ "name": "Temperature Sensor", "description": "An ambient temperature sensor.", "unit": "celsius", "value": 34, "gpio": 12 } websockets... :8:13  
{ "name": "Temperature Sensor", "description": "An ambient temperature sensor.", "unit": "celsius", "value": 22, "gpio": 12 } websockets... :8:13
```

Not all devices can speak HTTP and WebSockets, can they?



VS

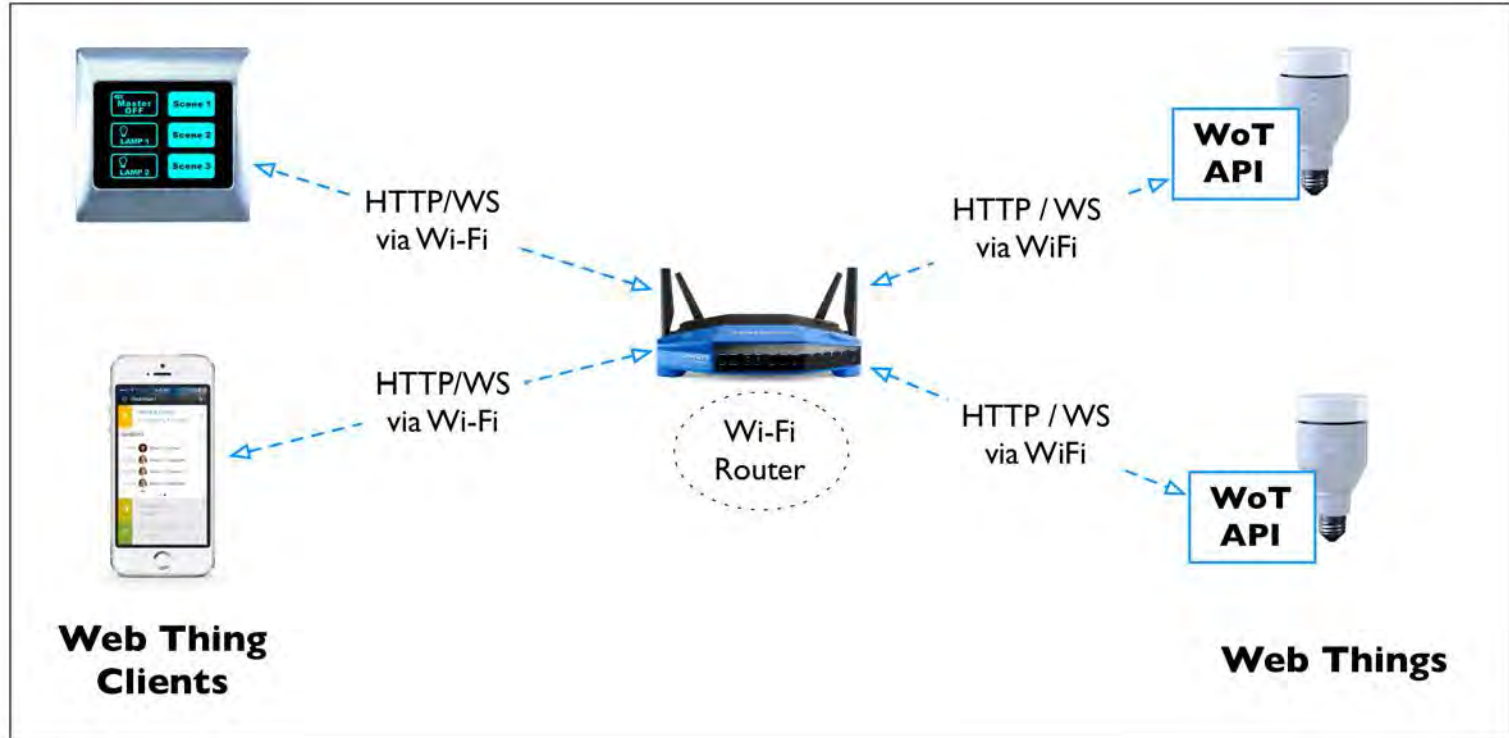


Not all devices can speak HTTP and WebSocket

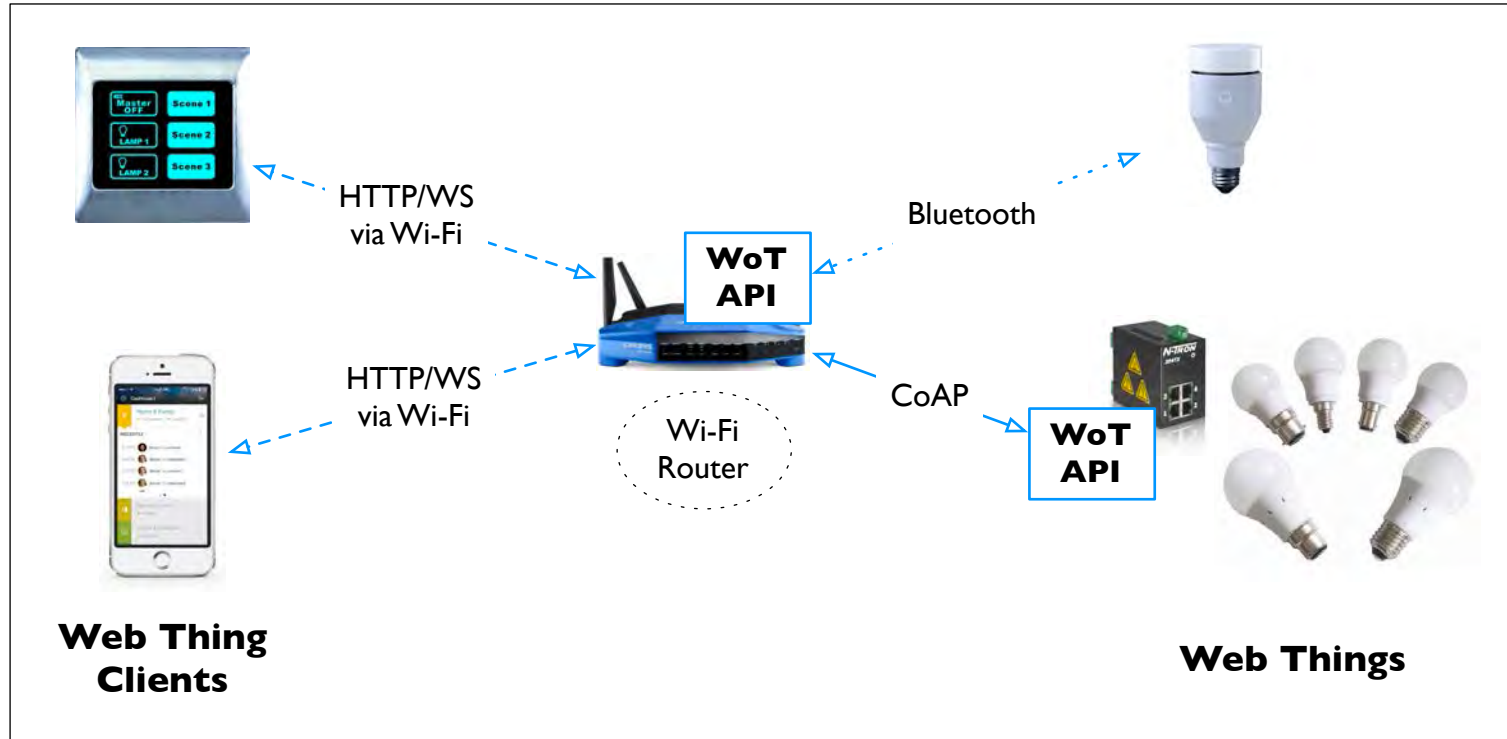


	Typical MQTT Protocol Stack	Typical MQTT-SN Protocol Stack	Typical CoAP Protocol Stack	
4. Application	MQTT	MQTT-SN	CoAP CoRE	Required
3. Transport	TCP	UDP	UDP	
2. Network (Internet)	IP	Not specified	6LoWPAN	Recommended
1. Physical (Link)	Not specified	Not specified	IEEE 802.15.4	

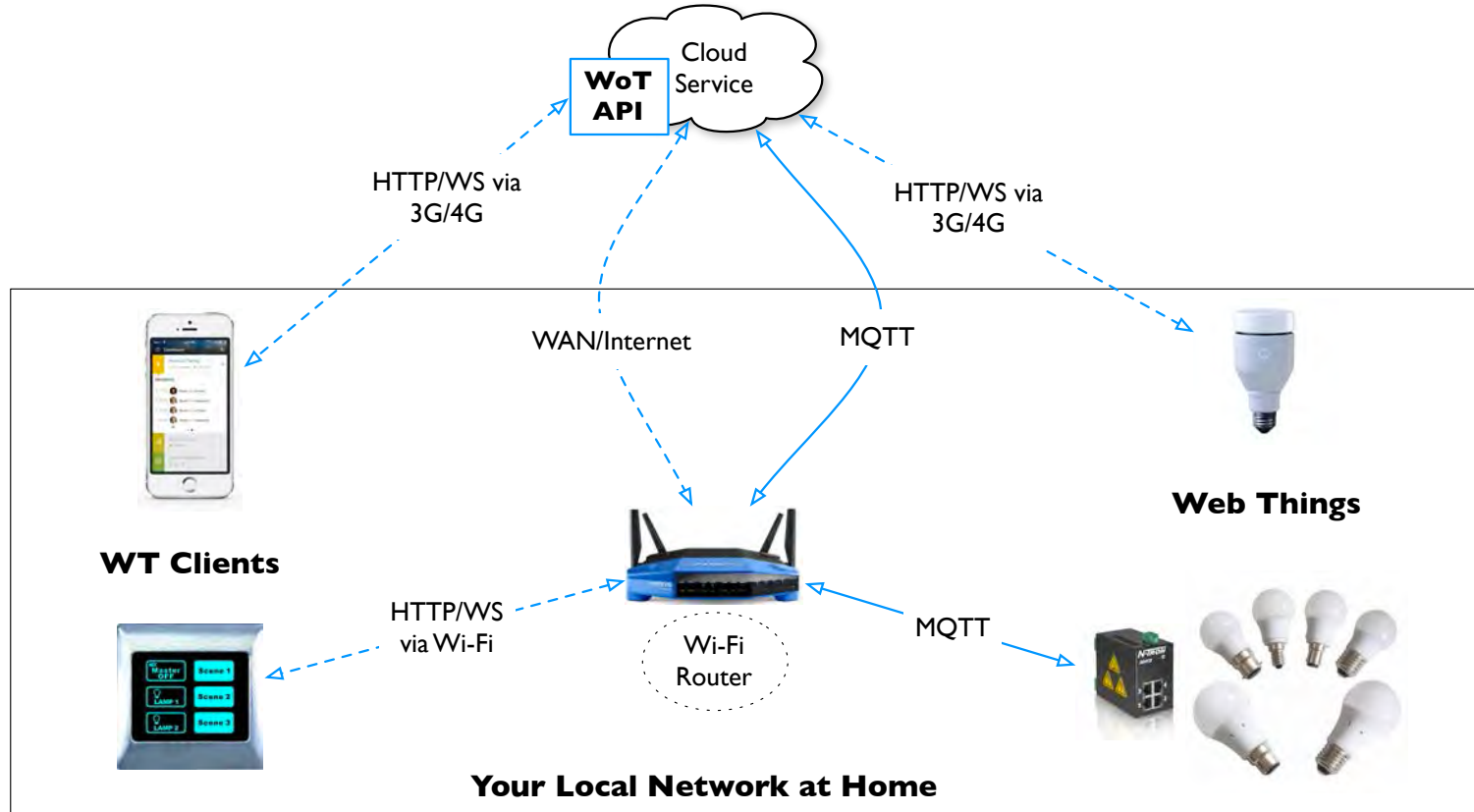
Integration pattern: direct communication



Integration pattern: Gateway



Integration pattern: Cloud



iHome – MQTT to Web Integration



- iHome uses EVERYTHING for their next-gen family of smart home products
 - Launched SmartPlug in July 2015, with suite of other products in development
 - One of just 5 initial HomeKit certified products
 - Uses out-the-box Marvell toolkit for devices with MQTT support
 - Integrated with SmartThings, Wink and Nest, and with iHome CRM and support system
 - Android and iOS apps for setup, creating scenes, timers and granting access to other users

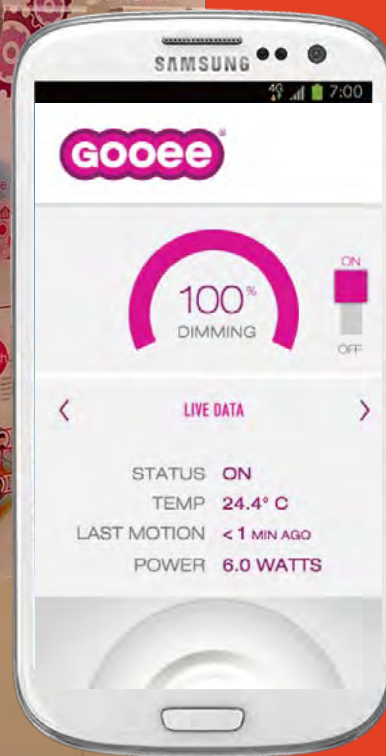
Watch video



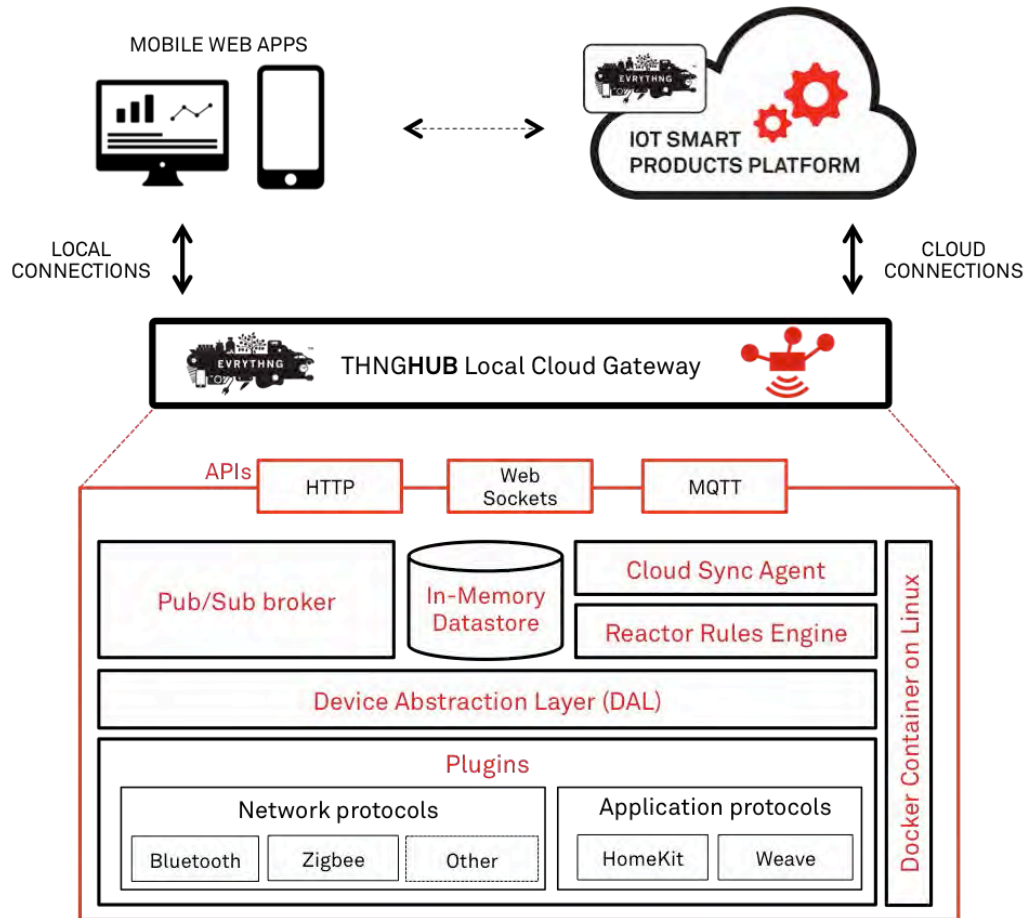
Goodee – Gateway integration



- Goodee uses EVERYTHING to sell Lighting-as-a-Service
 - Transforms dumb lights into smart services
 - Smart bulb for remote control, with motion sensors for retail traffic monitoring & security
 - Energy management & lower maintenance costs
 - Greater control and flexibility



THNGHUB: a WoT Gateway



- Multi-protocol support including Zigbee, Bluetooth, WiFi, Ethernet
 - Modular protocols support via additional plugins
 - Any language (DAL)
- Local Web API via HTTP/REST, WebSockets, M2M API via MQTT
- Local version of EVERYTHING's Reactor™ Rules Engine
- Runs on Linux (ARM or x86/64), supports most gateway architectures
- Deployed as secure, virtualized docker containers on any Linux appliance



IN THE NEWS

AVERY DENNISON AND EVRYTHING SWITCH ON THE APPAREL INDUSTRY WITH 10 BILLION PRODUCTS IN WORLD'S LARGEST IOT DEPLOYMENT

Apr 18, 2016

Apparel and footwear products from the world's largest brands have the power to be born digital and given unique, item-level digital identities with the Janela™ Smart Products Platform

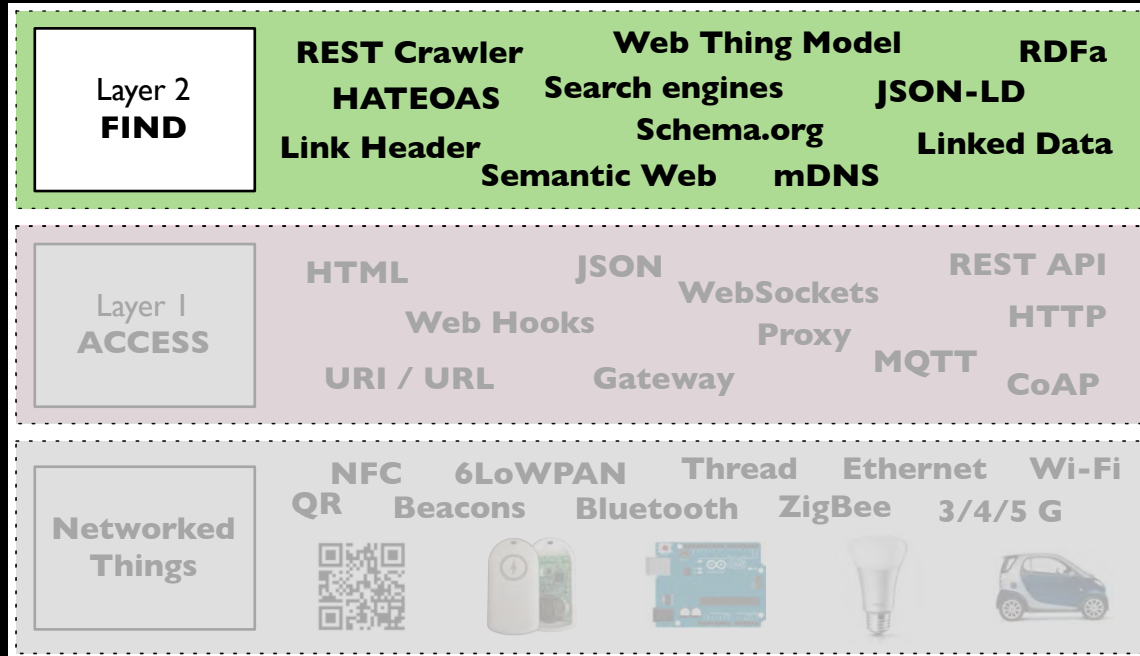
- 10 Billion products through Avery Dennison labels
- Apparel products are “born digital”
- Based on the simple concepts of URLs and Web API for each thing

Discussion: Layer 1 - Access



- All protocols need to meet at the Application Layer
 - The Web
- Other protocols can be translated to HTTP/WS
 - MQTT (quality of service, remote actuation)
 - CoAP (battery, low power)
- Pick the simplest path:
 - Simplicity **does** matter!
 - UDP NAT traversal issues, etc.

2. Find Layer



Web Thing Model

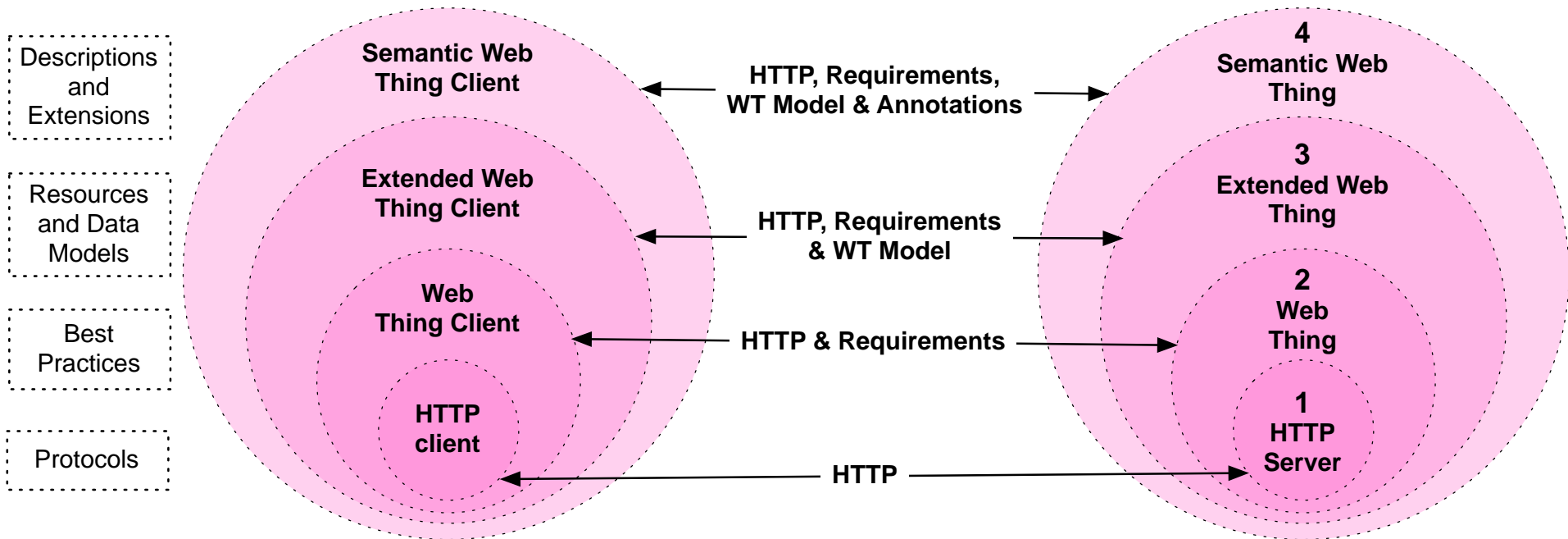


W3C Member Submission

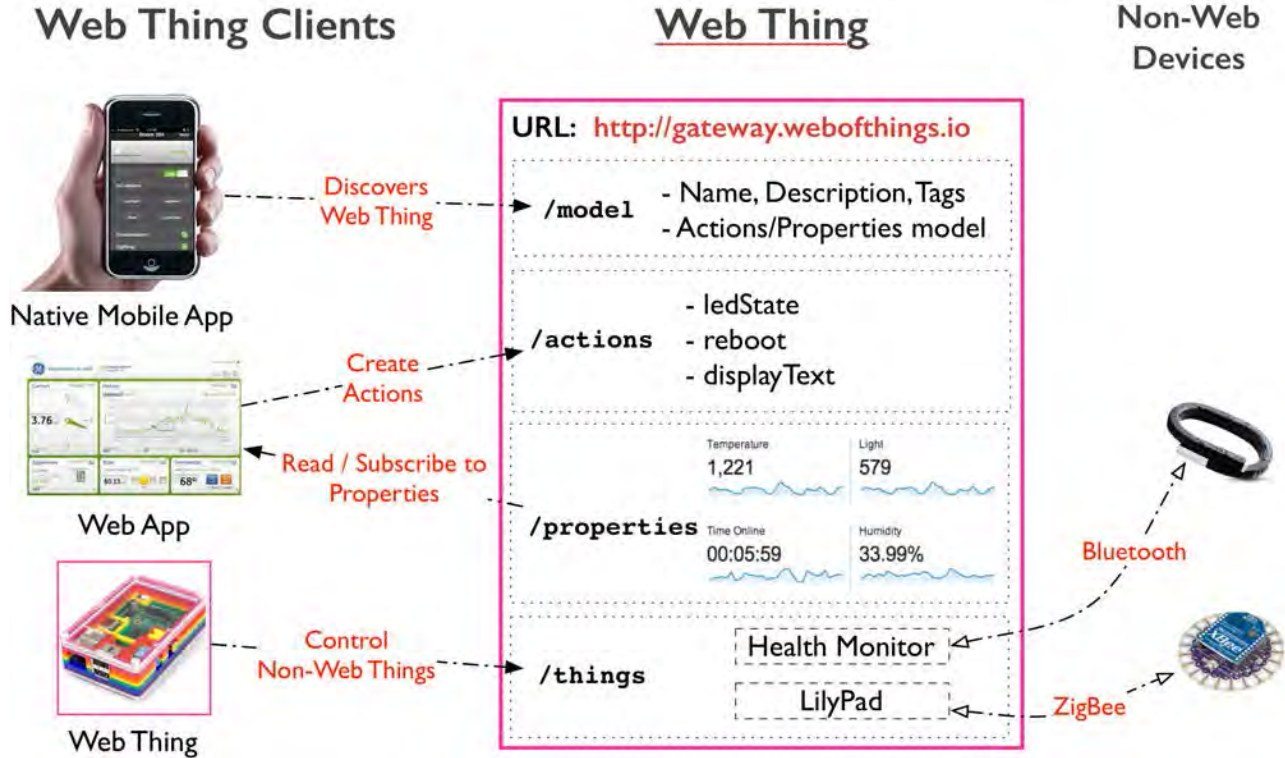
<http://model.webofthings.io>
<http://gateway.webofthings.io>

Web Thing Model

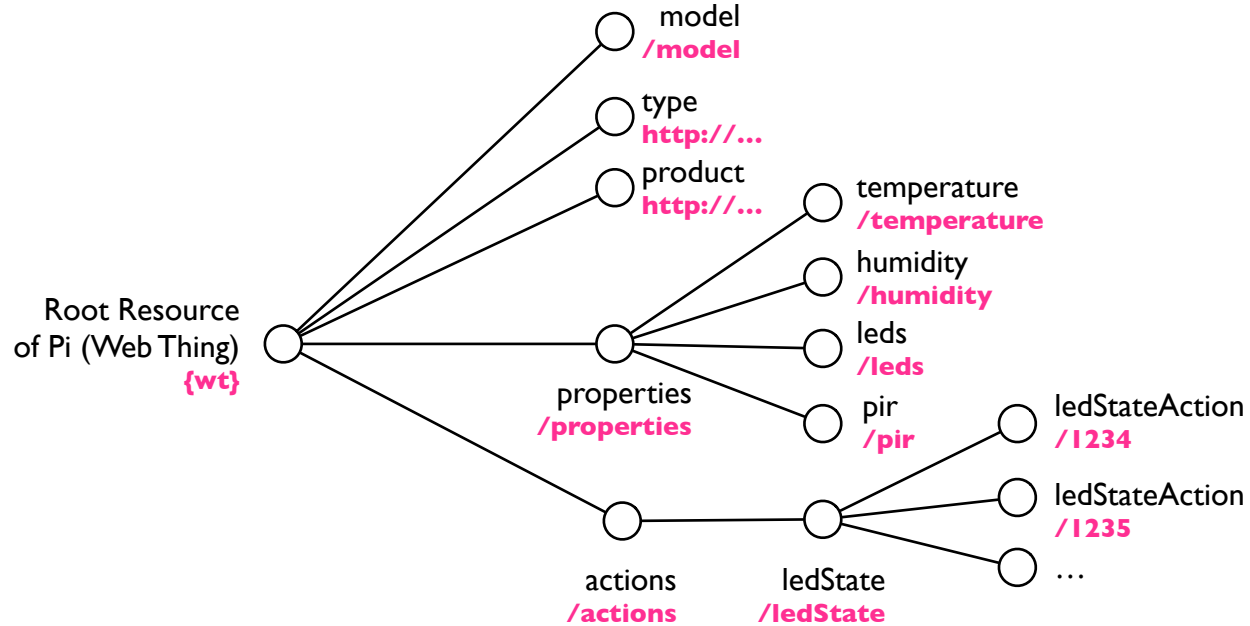
W3C Member Submission 24 August 2015



Web Things Model

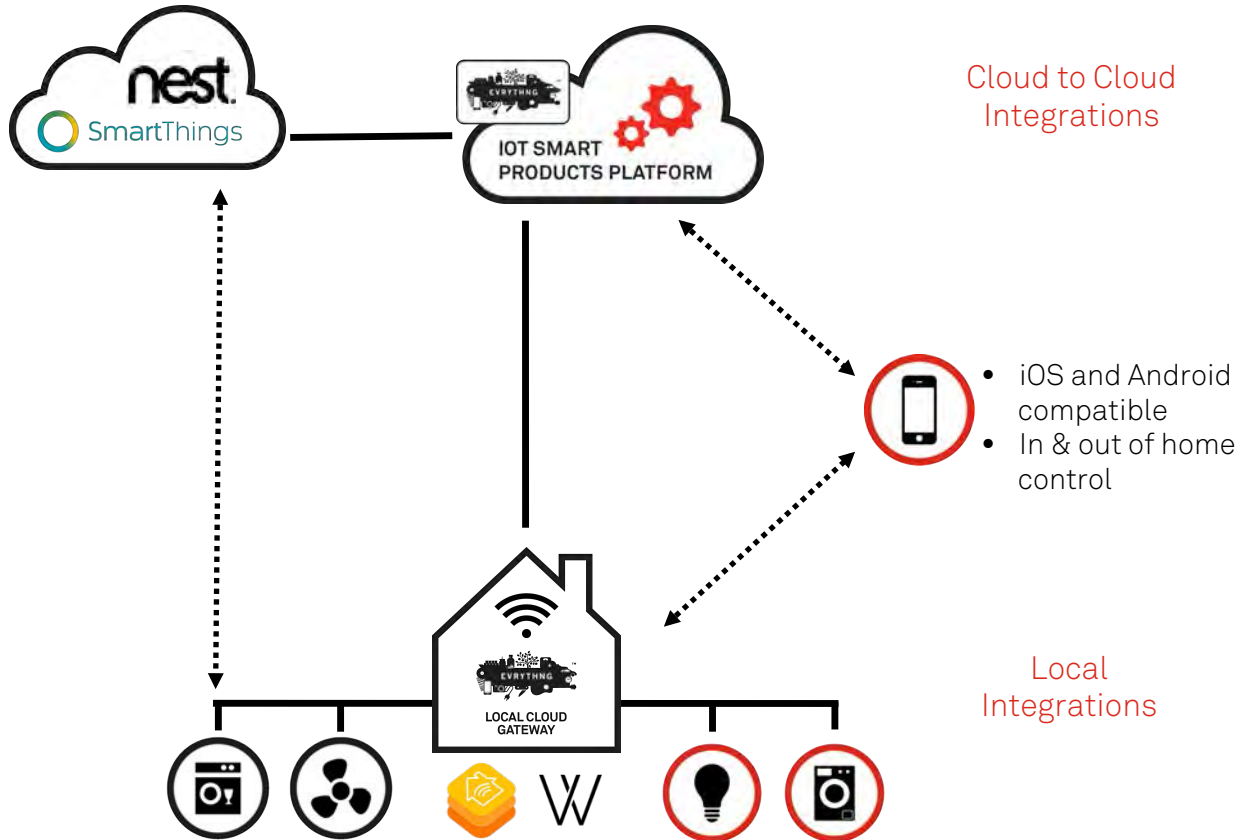


An example



Demo!

Semantic Smart Home Integrations



Platform integrations via Cloud to Cloud modules

- Enables devices to be managed by EVERYTHING & accessible and controlled from 3rd party systems and apps. e.g. Nest, Wink or SmartThings
- Integration module includes:
 - User & device mapping
 - Synchronization
 - Custom Logic

Local integrations via THNGHUB Local Cloud Gateway

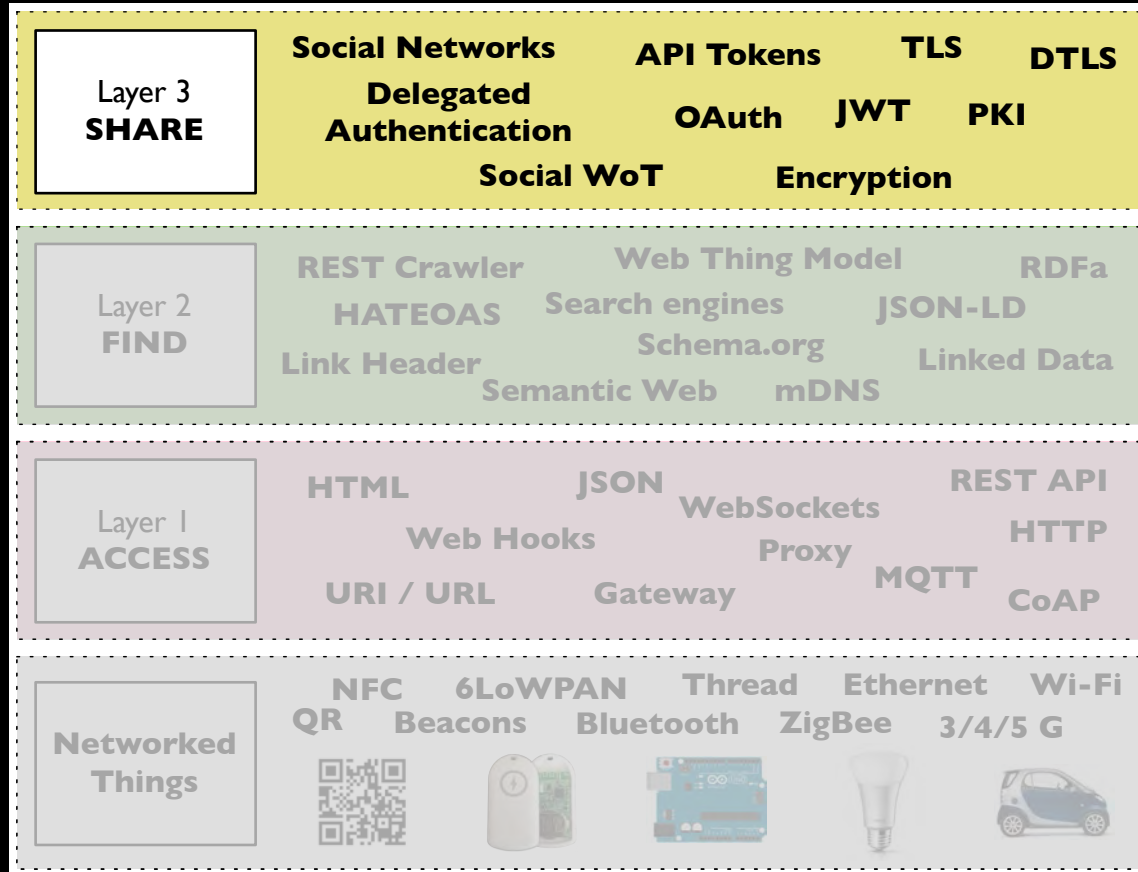
- Enables interoperability with Homekit & Weave
- Connection to 3rd party products via device APIs

Discussion: Layer 2 - Find

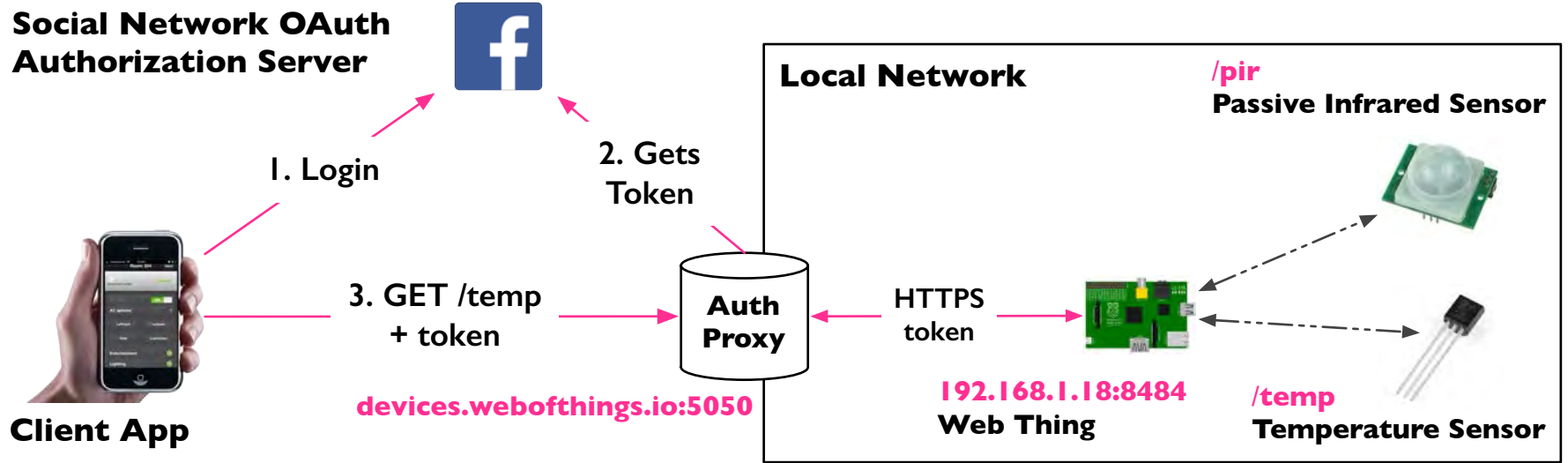


- Using Web protocols is the first step towards true interoperability
 - Helps “opening” devices, freeing them through APIs
- Web protocols cover the “How” not the “What”
 - Great for humans, challenging for machines
 - Semantic Web, JSON-LD
 - First W3C proposal for the Semantic Web of Things:
<http://model.webofthings.io>
 - Schema.org
 - See also <https://www.w3.org/WoT/IG/>

3. Share Layer



The Social Web of Things





About Authentication Resources Gateways Shares

Here you can see all Resources that have been shared with you. You can either open a resource in a new browser window, display it directly in friends & things or you can make custom RESTful HTTP requests to it. Further you can register Feeds in order to send updates to it in regular time periods.

- ▶ localhost:8082/EnergyMonitor
- ▶ localhost:8082/EnergyMonitor/ploggs.html
- ▼ localhost:8082/EnergyMonitor/ploggs/Kettle/status.html

Accessed twice.

POST /gateways/localhost:8082/resources/EnergyMonitor/ploggs/Kettle/status.html

Request Data:
URL-encoded data to be sent to the resource, e.g.: `key1=value1&key2=value2`.

status=off

Status of Kettle
Status: off



About Authentication Resources Gateways Shares

Here you can see all Resources that you have shared with your friends or you can share new Resources. For existing Shares, you can display usage statistics in order to see whether it was worth sharing that Resource.

Gateway:
Select a gateway.
localhost:8082

Social Network:
Select a Social Network to display friends.

User:
Select a friend so share a resource with.

URL:
Select a Resource to be shared. Loading all available resources might take some time.. please be patient.

- ✓ EnergyMonitor (/EnergyMonitor)
- Overall load of the current place (0-100) (/EnergyMonitor/load.html)
- List all Ploggs (/EnergyMonitor/ploggs.html)
- Kettle (/EnergyMonitor/ploggs/Kettle.html)**
- EnergyMonitor/ploggs/Kettle/status.html
- All Ploggs (/EnergyMonitor/ploggs/all)

Discussion: Layer 3 - Share



- Security by obscurity never helps
 - Better off with open protocols!
- Technical challenges
 - TLS can be heavy for resource constrained devices
 - See DTLS, TLS on UDP for constrained devices
- Things on the Web = Things on the Web!
 - DDoS attacks
 - UDP flooding / TCP SYN attacks
 - Hacking the physical world
 - E.g., Shodan, Baby Monitors



Explore the Internet of Things

Use Shodan to discover which of your devices are connected to the Internet, where they are located and who is using them.



See the Big Picture

Websites are just one part of the Internet. There are power plants, Smart TVs, refrigerators and much more that can be found with Shodan!



Monitor Network Security

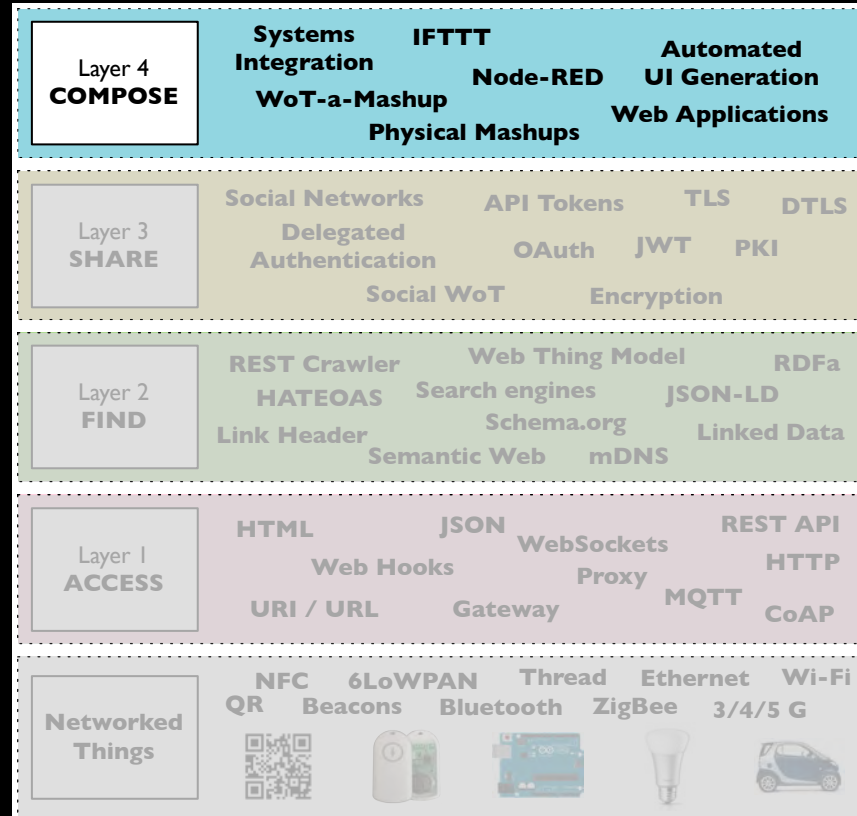
Keep track of all the computers on your network that are directly accessible from the Internet. Shodan lets you understand your digital footprint.



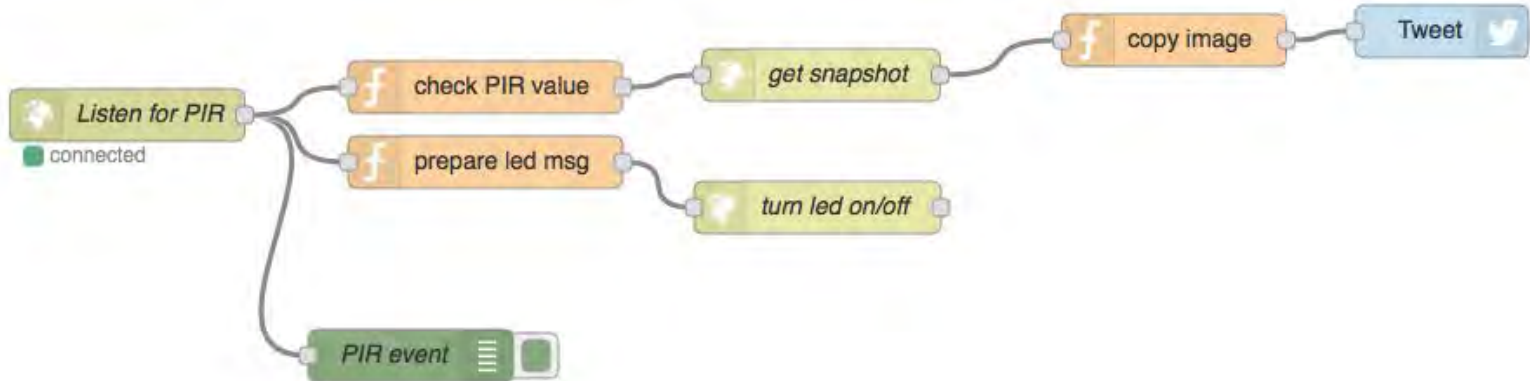
Get a Competitive Advantage

Who is using your product? Where are they located? Use Shodan to perform empirical market intelligence.

4. Compose Layer



Composing the real-world: Physical Mashups



<http://node-red.org>

Physical Mashups with IFTTT



New tweet by specific user
[@wotbook](#)

Make a web request

Recipe Title

If new tweet by specific user @@wotbook, then make a web request

use '#' to add tags

Turn off

Publish

Check now

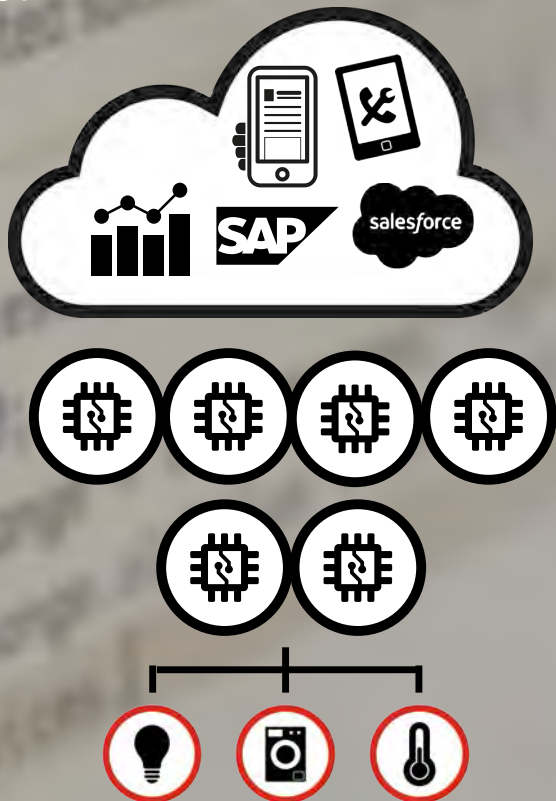
Log

Delete

created January 17, 2016
last run March 22, 2016
run 10 times

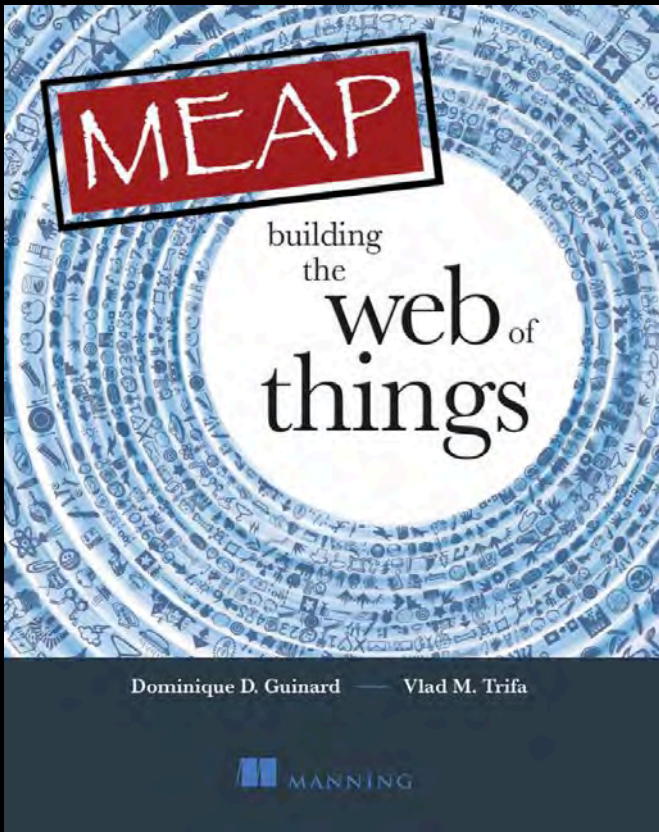
<http://ifttt.com>

The Reactor



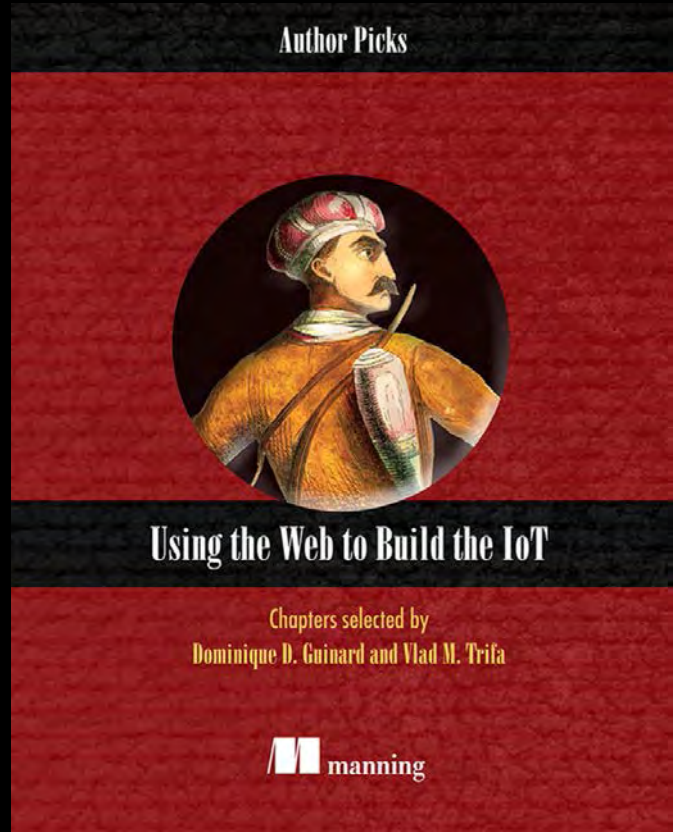
- Usage: reacting to events
 - Generate alerts for users via apps, SMS, calls
 - Generate events in other systems
 - Physical mashups
- Massively scalable scripting run-time
 - Unlimited horizontal scale
 - Ephemeral virtual instances
- Secure
 - Data isolation
 - One event, one instance
- Flexible
 - Node.js runtime
 - Full NPM access

<https://developers.evrythng.com/>



20% off “Building the Web of Things”
with code “guid20evry”

See: <http://book.webofthings.io>



Free e-book with sample
chapters